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The Sexuality of Bees.

BY PROFESSOR LEUCKART, OF GIESSEN.

An animated and protracted controversy has subsisted, among apiarians and naturalists, respecting the sex of the three kinds or classes of bees which are consociated in the hive and constitute the community or colony. Until quite recently, the most divergent and conflicting views and opinions were advanced in the Bienenzeitung and other publications. This long controversy is now ended, and the warmly mooted question settled:—it being universally conceded that,

1. *The queen and the drones are the only individuals in which sexuality is perfectly developed:*

   A, *the queen being of the female sex;*

   B, *the drones being of the male sex.*

2. *The workers, in a sexual aspect, are imperfectly developed creatures: that is, imperfectly developed females.*

Had apiarians paid more attention to the results of scientific research in natural history, these conclusions would have been reached and become established at a much earlier period. Nearly two centuries ago (1672), the celebrated naturalist, Swammerdam, clearly demonstrated that the queen is a female, and that the drones are males—statements subsequently confirmed by numerous inquirers, among the later of whom I will mention only Prof. Von Siebold. Still, a knowledge of the true character of the workers is of later date. True, SWAMMERDAM already was aware that the workers are sexually undeveloped (he called them *natural eunuchs*); but he was rather inclined to regard them as stunted males, than as undeveloped females. If their essential femininity had been earlier recognized, the important and interesting truth promulgated by SCHIRACH (1767), that a queen could be reared from a worker larva, would not so long and so generally have been received with doubt and disbelief. The discovery of the real nature of the workers, for which we are indebted to the investigations and dissections made by Miss JURINE, in 1813, first furnished a key for a correct apprehension of that remarkable fact.

The masculinity of the drones was most generally and most pertinaciously doubted or denied by apiarians—many of whom have only recently yielded a reluctant assent. They regarded drones as anything but males. To the novice in natural science, it seemed utterly incredible that the male sex, which in the human race and the higher orders of animals holds the privileged and ruling rank, should in any case be sunk to so subordinate a condition as that occupied by the drones in the economy of the hive. The argument was plausible; for most apiarians were not aware that in many of the lower order of animals, the males sink to a position still more humble than that held by the drones among the bees.

There are not only numerous classes of creatures whose males, like the drones, make their appearance only at certain seasons, while the females live perhaps for years; but some also among which the males exist, simply for a brief term, to perpetuate the race. Thus among the Rotiferæ, the males are born, copulate and die—the entire absence alike of mouth and alimentary canal, rendering the reception and digestion of nutriment impossible, and limiting the duration of life to the briefest space of time. In other instances, as in that of the parasitic crab (*Lernaeadæ*), the female exceeds the male many thousand-fold in bulk; the latter living on the body of the former, and being so minute in size as to be

scarcely visible by the naked eye; whilst the former measures several inches in length.

Such facts as these divest of its singularity the apparent unnaturalness of the subordinate position occupied by the drone, when contrasted with the sexual relations subsisting in the higher orders of animal life.

The question respecting the sex of the several kinds of bees may be solved, either empirically, by observing their habits, or scientifically, by dissection and microscopic examination.

One empirical evidence of the feminine nature of the workers, is furnished by the fact already referred to, that a worker larva does, under certain conditions (as abundant supplies of food and enlargement of the cell), become a queen. And in like manner, the masculine nature of the drone is proven by the fact that, in the absence of drones, no queen becomes perfectly fertile. But this kind of proof is ever circumstantial, and leaves room for gross misconception and error. Thus, for instance, queens sometimes become fertile when drones are no longer seen; and it may hence be argued that these are not needed. But it is well known that they are occasionally tolerated in a hive, till late in autumn or even till mid-winter; and they are also sometimes found as early as in February and March. Hence, mistake and deception may easily occur; and it was invariably on such empirical evidence that some distinguished apiarians relied, when they strove to defend and maintain those singular and discordant views alluded to at the beginning of this article.

Under such circumstances, we can concede decisive force only to the direct investigations of the anatomist and the physiologist; and these have settled the question conclusively.

Nevertheless, the question which we are here treating is so important, of such fundamental significance, that the apiarian cannot be expected to yield assent to the mere *ipse dixit* of the physiologist. He must be placed in a position to scrutinize the particular anatomical facts on which the demonstrator bases his conclusions, that he may be able to form for himself an independent and intelligent judgment in the premises.

Let us see what the physiologist adduces in support of his views, or as the evidence on which he relies in making up his opinion.

1. The Drones are Males.

a. In the entire sphere of animated nature, it is the peculiar function of the male individual to secrete in his sexual organs, or in those genital glands known as the testes, a substance called semen or sperm, which exerts a fertilizing influence on the ova formed in the ovaries of the female. The secretion of this sperm is the most important as well as the most decisive characteristic of the male sex. Whenever, in any creature, we discover the secretion of sperm, we must, under all circumstances, regard it as being a male, however divergent and anomalous its organization may in other respects seem to be.

But what are the distinguishing characteristics of the sperm? To the ordinary observer, it seems to be only a viscid whitish or cream-colored fluid, whilst the naturalist, with the aid of the microscope, detects therein a countless multitude of living corpuscles which, despite of their minuteness, possess so peculiar a form that it is impossible to confound them with any other of the component portions of the animal body. Generally, these corpuscles are filamentous in shape; sometimes simple hairs; sometimes with a globular, cylindrical or ovoid head; yet always so characteristically formed, that though ignorant of their immediate origin, we can in many instances easily determine the animal, or at least the class of animals from which the sperm emanated. Superadded to this, is the circumstance that these filaments, in their fully developed generative condition, possess the power of voluntary and apparently independent locomotion, which is usually wanting in animal tissues, and which often so forcibly remind us of the movements of certain microscopic organisms, that for a long time they were regarded as such.

But it must not be supposed that these seminal corpuscles are found *ab initio*, and at all times in the seminal glands of male creatures. They become developed only at the age of puberty, and then only when the animal is *in heat;* though in an essentially corresponding manner in all animals. The testes of immature animals, and of such as are not in heat, contain, instead of the ultimate seminal corpuscles, a densely compacted mass of pellucid vesicles, which, at the approach of puberty, gradually enlarge, displaying internally a multitude of similar though secondary vesicles, which finally become developed as the characteristic seminal elements. Not unfrequently, the filaments of the original vesicles are observed still cohering in one mass for a considerable period, before the final separation takes place.

Precisely such corpuscles as here described originate also, and become developed in the manner stated, in the seminal glands of the drones. Like the seminal corpuscles of insects in general, they have an attenuate and simple filamentous shape, are of proportionably great length, with an active serpentine motion, so that the waving

of the aggregate mass resembles that of a grain-field influenced by a gentle breeze. Both Prof. Von Siebold and myself, while at Seebach in the summer of 1855, repeatedly exhibited to the Baron of Berlepsch and his beekeeper, these seminal filaments, under the microscope, as they were taken from the sexual organs of drones. Francis Hoffman, of Vienna, one of the few apiarians who can properly dissect and prepare subjects for the microscope, has likewise detected these seminal filaments, and furnished an accurate and interesting account of them for the Bienenzeitung.

But in the drone, the development of these seminal filaments takes place only once in the life of the insect, and this at the latter period of its existence as a *pupa*. When the drone emerges from his cell, the seminal elements have already been transformed into mobile and fructifying filaments, which gradually leave the testes and collocate, in larger masses, in distinct portions of the seminal ducts, the so-called seminal vesicles, in readiness for transmission into the female sexual organs.

We thus perceive why the testes of mature drones appear so diminutive and shrunken, in comparison with the ovaries of the queen. After the egress of the seminal filaments, the testes gradually shrink up and assume the appearance of two flat reniform bodies, which are found above the intestines and immediately beneath the exterior integuments of the abdomen, and are composed of a membranous tissue permeated by numerous air vessels.

If we would examine the testes of the drone in their amplest development, we must take the insect, as already remarked, in the later period of its pupa state. According to my observations, they present, at this stage, the appearance of a pair of bean-shaped bodies of considerable magnitude, meeting above the intestines along the central line of the back, and consist, like the ovaries of the queen (which they nearly equal in size), of numerous minute tubes (*fig.* 1, a) which radiate from the upper ends of the two branches of the seminal duct, and are in each compacted in a dense mass. Of such tubes, I counted from 200 to 230 in each of these bean-shaped bodies; each containing, according to the period of examination, either innumerable mobile filaments, or fully developed vesicles.

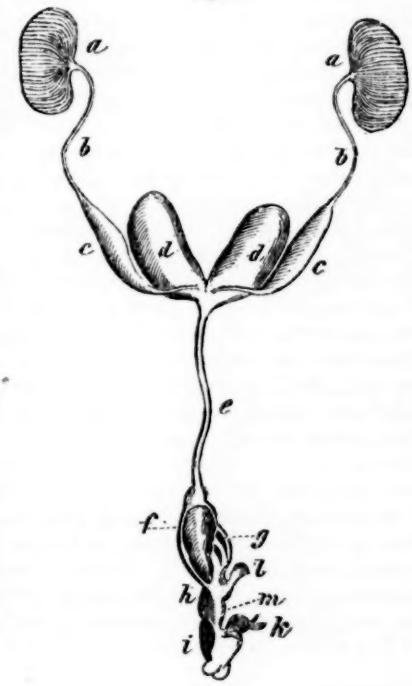
b. But it is not merely by the presence or development of the seminal filaments, that the masculinity of the drones is indicated. The anatomical structure of the entire sexual apparatus renders this so obvious, that the older naturalists (Swammerdam, Reaumur and others), though ignorant of the existence of the seminal filaments, could not for an instant doubt the masculine character of these creatures. As in man and the higher order of animals in general, so in insects also, the development of the sexual organs presents certain characteristic traits most distinctly indicating their male or female nature.

But before describing these specific peculiarities, I may state that the sexual organs of the bees, like those of insects in general, correspond in the males and females, in the correlation of the parts. In both cases (*compare figs.* 1 *and* 2,) we find, in connection with the sexual glands which are situated over the intestines, a Y-shaped duct, the stem of which terminates in a point of the abdomen immediately under the anal orifice, whilst the branches beyond the bifurcation embrace the sides of the digestive organs, extending upward to connect with sexual glands above mentioned.

Yet, notwithstanding this analogous arrangement, the male and the female organs differ characteristically from each other.

As characteristic of the male organs must primarily be regarded the presence of a penis, designed to enter the female organs in coition and transmit the semen. Yet we must not conceive of it as a special tissue, distinct and separate from the other sexual organs. In insects, the penis is nothing more than the terminal section of the stem of the oviduct, fitted for its special function by the development of corneous adjuncts exceedingly diversified in form and structure. To it, in male insects, are very generally appended a pair of tubular glands, which unite with the main stem of the duct near the point of bifurcation, and were formerly regarded as seminal vesicles. These appended glands contain a milky secretion, which envelopes and cements the seminal filaments into distinct masses or spermatophores, in which form they enter the female receptacle during coition.

Fig. 1.



If we now examine illustration, *fig.* 1, (which I flatter myself is an accurate representation of the sexual apparatus of the drone), we shall find all the characteristics of masculinity which we have thus endeavored to specify. In *d*, we have the two appendicular glands, which in the bee are peculiarly short and compact. These terminate in the upper end of the main stem of the oviduct *e*, whilst the lower portion of this duct (from *f* onward) is converted into a penis. The two branches of the duct, *b b*, above the bifurcation, present a cylindrical enlargement of the lower half of each, *c c*, in which the semen, after leaving the testes, *a a*, is retained for a season before descending still further to the incipient section of the penis, where, in combination with the secreted matter derived from the appendicular glands, it forms a so-called spermatophore—one of which is exhibited in the cut at *f*, being a pear-shaped body distending the upper portion of the penis in a bulbous manner.

If, as indeed would seem most natural, we should include under the term penis all that portion of the sexual apparatus immediately concerned in copulation, we can still only apply the term in the sense above indicated. Thus, the penis of the drone is a cylindrical tube or duct coated internally with various corneous tissues, being itself simply a continuation, or more accurately, an integral part of the main duct peculiarly developed. In copulation, this tubular penis becomes inverted, like the fingers of a glove turned inside out, and when in that state, appears like an external appendage of the sexual orifice—the previously internal surface, with its corneous tissue, having now become the exterior. Prof. Von Siebold uses the term penis in a different sense, and applies it only to a portion of the corneous tissue of the internal surface.

If the penis of the drone were simply a cylindrical tube, it would in its inverted state present an appearance similar to what is seen in a prolapse of the rectum, in which the inverted portion of the intestine forms a sheath enveloping another portion, unnaturally protruded indeed, but not yet exposed. The terminal orifice of this sheath is the entrance to the yet enclosed portion of the intestine, which, as the protrusion advances, is inverted and becomes itself the sheath. Like the original anal orifice—to adhere to our illustration—the terminal orifice represents in fact a cross section of the rectum, now indeed no longer coincident with the end of the intestine, but with a line originally lying higher up within the body. The further the prolapse extrudes, the longer does the sheath thus become, and the further removed will the virtual cross section be from the true end of the intestine, really receding higher up.

The relations of the inverted penis correspond essentially with those of the illustration taken from a not unfrequent disease. By pressure on the abdomen of the drone, directed towards its apex, we can perceive how the penis becomes gradually more and more inverted and turned into a sheath, which, when the inversion is completed, encloses the upper, thinner, and yet unextruded portion of the stem of the oviduct. At first, this inversion is limited to that portion of the penis situated nearest to the sexual orifice—that is, to the terminal part. But by continued pressure, the inversion progresses, extending more and more to the anterior portions, and finally the whole organ is turned inside out and prolapsed. Now, whether the penis be wholly or only in part inverted, it still exhibits, at the virtual cross section, a passage communicating with the yet uninverted portion, and thence with that portion of the seminal duct which never becomes inverted or protruded. Mr. Kleine is of opinion that the penis of the drone is an independent tissue, the interior of which is distinct and separate from the oviduct; but by means of the microscope, the connection and continuity of the passage can be distinctly seen. The position of the spermatophore also proves this connection and continuity, for it does not correspond with the end of the oviduct, but with the anterior portion of the penis.

If, at first view, the relations of the parts appear to be somewhat complicated in the case of the drone, this results from the fact that the penis is not simply a cylindrical tube, like the prolapsed rectum, but an articulated structure variously developed in its several parts.

It will, I conceive, be most convenient to subdivide the penis into three sections, the terminal, the middle, and the upper or bulb. The first mentioned, is that which first presents itself in the process of inversion, and with the exposure of the last the process is completed.

The terminal section, easily recognized in fig. 1, is the widest. In its natural position, it appears as a nearly globular or drum-shaped tissue communicating with the sexual orifice, and having two pretty large brownish spots on opposite sides, corresponding with the ventral and the dorsal region. Under the microscope, we discern that the spot on the inner ventral surface is composed of a fringe of stiff brownish hairs turned towards the rear, which of course point in the opposite direction when, by inversion, the inner surface is turned outward. They consequently rise and oppose the retraction of the organ from the sheath of the vagina after copulation.

The coloring of the dorsal spot does not result from a hairy fringe, but from a peculiar scaly corrugation pertaining likewise to the inner surface, and which, when inverted, increases the number and extent of the points of resistance presented to the retraction of the penis. Close to this dorsal spot, and near the terminal section of the penis, two tapering brownish cul-de-sacs (fig. 1, *k*,) rise, which are likewise turned inside out in copulation, and constitute the two well known curved horns that give to the sexual apparatus of the drone its singular appearance. (In *fig.* 2, which represents a partially inverted penis, only one of these horns is shown—the other being omitted to simplify the representation.) The yellow color of the horns results from an arrangement of scales similar to that noticed on the dorsal spot.

Next above the terminal section of the penis, is a distinctly defined narrower part—the middle section—which, on continued pressure, extrudes between the two just mentioned horns, and resembles a slender spine curved slightly upward. On the dorsal and ventral sides of this middle piece, are also seen two remarkable brownish spots. The latter of these consists of five or six consecutive obliquely curved lines; and the former, placed far back, where the middle piece is divided from the terminal section by a deep constriction, resembles a horseshoe in shape. These spots result in each case from a dense fringe of bristly hairs, more minute than those on the inner ventral surface of the terminal section, and the remarks made with reference to them, apply to these likewise.

A further characteristic of the middle section, is a minute mace-shaped *cul-de-sac* (*fig.* 1, *l*,) projecting from the dorsal region of its upper and somewhat thicker part; and which likewise becomes protruded, when the middle section is inverted. Previous thereto, and while remaining in a state of repose, the margin of this *cul-de-sac* is variously folded and corrugated.

As respects the upper section or bulb of the penis, it appears when empty (that is, in the absence of a spermatophore,) like a pear or heart-shaped tumor, enclosed on its dorsal side by a brace of horny scales. The presence of a spermatophore (*fig.* 1, *f*,) modifies the form of this bulb in several respects, yet only during its continuance therein, as the bulb immediately resumes its original shape after the discharge of the spermatophore.

At first view, it would seem as if there were four of those horny scales already mentioned. But on closer examination, it will be found that there are really only two. The deceptive appearance is produced by the fact that the inner sharply defined edge of both scales, is rendered more conspicuous than the rest of the surface, by its higher coloring and the direction of its cusps, and are hence readily taken to be distinct objects. The cusps are detached from the side walls embraced by the scales, and extend freely into the cavity of the bulb. After the inversion of the penis, they resemble two short prongs, curved towards the head of the drone, and like the bristly hairs of the other sections, serve to retard the retraction of the penis. The same is true also of the lateral portions of the horny scales, their posterior edges having various prominently developed projections.

This singular structure and conformation of the parts, makes it manifest that the union of the drone and queen in copulation, must be such as involves a disruption of the penis on separation.

The force which effects the inversion of the penis is very simple. It consists of the pressure which the drone, by a violent constriction of the muscles of the abdomen, exerts on the sexual apparatus which lies loosely in the cavity of the belly—being connected with the body only at the rim of the sexual orifice. Fancy the finger of a glove partly inverted. If the upper portion be now inflated with air and then compressed, the point of the finger will be gradually forced out and also become inverted. The operation is almost precisely similar in the case of the drone. The side walls of the abdomen represent a sac which is filled with blood and intestines, while its margins are recurved and continued inward, constituting the sexual organs of the drone. As soon as the sides of the abdomen contract by the action of the muscles, the penis is projected and inverted—first presenting simply the terminal section, then the middle portion, and finally the bulb—thus liberating and discharging the included spermatophore. The more completely the abdomen is filled and distended, the more readily and perfectly will the sexual apparatus be thrown forth inverted. Now, among the internal organs of the drone, there are some which can become inflated only under certain conditions. Such are the tracheæ, which permeate the body as ramified tubes, with occasional enlargements or sacs of variable dimensions. The most of these, while in a state of repose, are collapsed and nearly empty; but they become somewhat charged with air while the insect is preparing to fly, and are only fully inflated when it is on the wing. The inflation of these tracheal tubes, presupposing the simultaneous closing of the spiracles, must very considerably increase the pressure exerted on the side

walls of the abdomen; and this enables us to perceive the reason for the remarkable fact that copulation is effected exclusively while the parties are flying. In a state of comparative repose, when the tracheal vessels are collapsed, the amount of pressure which the drone could exert on the contents of the abdomen, would not suffice to effect that perfect inversion of the copulating organs, which is indispensable to liberate the spermatophore and introduce it in the vaginal sheath of the queen.

It has indeed been urged as an objection to this view of the matter, that if the head of a drone be cut off when he is in a condition of repose, the genital organs will still be thrust forth inverted. The fact is true, and may easily be physiologically explained. The decapitation violently affects the nervous system, and this superinduces an instantaneous convulsive constriction of the abdomen, followed by the extrusion and inversion of the genital organs. But this inversion is by no means complete, but invariably—so far as my observations extend—partial only. The terminal section of the penis only with its horns, is thereby extruded; or with it at most, only occasionally also, a portion of the middle section; whilst the bulb always remains unmoved and unaffected. When this latter, likewise, is to be extruded, and the spermatophore liberated and discharged, those physically favorable conditions are indispensable, which can occur only, in adequate force, during the flight of the insect.

Moreover, we are not to imagine that the drone, when about to copulate, voluntarily extrudes the organ. The process is decidedly otherwise, as is manifest from the fact that the organ, with its various and irregular adjuncts, could not possibly thus enter the vagina, however widely distended this might be. Obviously, inversion and insertion are simultaneous. Doubtless, the terminal point of the abdomen is inserted in the sheath of the vagina, before the extrusion and inversion occur —thus affording the successively inverted parts time to assume their proper relative position within the cavity of the vagina.

The inverted organ, besides, is of very considerable volume; much greater, indeed, than in its unextruded state. This results from its being then engorged with the blood circulating in the vessels of the abdomen, whereby its cavernous tissues, previously collapsed, have become filled, and as it were inflated. This engorgement produces a certain degree of expansion and rigidity. Where, in the collapsed state of the vessels, softness and flaccidity are seen, turgescence is more or less conspicuous after inversion.

But I should become tedious, were I to describe in detail the form of the inverted organ, with all its peculiarities. I must therefore content myself with referring the reader to the annexed cut, which is a representation of the extruded and inverted penis, and in which the corresponding parts are designated by the same letters as in *fig.* 1. The more important and more remarkable features of the inverted organ have, besides, been already sufficiently adverted to in the course of the preceding statements.

Fig. 2.

In the process of inversion, moreover, the internal portions of the organ would obviously undergo no inconsiderable distortion, if this had not been specially provided for in the organization of the drone. The seminal duct, for instance, which would be most directly affected, is distinguished not only by great length and convolution, admitting of considerable displacement, but is, in addition, so exceedingly elastic that it may be stretched to more than twice its ordinary length. The disruption of the sexual organs involves also the severing of this duct, sometimes in its upper part, sometimes in the lower. In the former case, the fragment adhering to the disrupted sexual organs appears as a filament, or "white thread," depending from the vagina of the queen, and is regarded as evidence of accomplished copulation.

c. What has here been stated respecting the sex of the drones, is true not only of those which are reared in drone cells from the eggs of a fecundated queen, but of all drones without distinction. Those originating from the eggs of unfecundated or drone-producing queens are, as I have ascertained, as perfectly developed and as fully virile as others. So are likewise those dwarf or diminutive drones, which are occasionally bred in worker cells. Nay, even in a drone hatched in a royal cell, though prematurely dead, sent to me by Mr. Kleine, I have unquestionably found seminal filaments and male organs. The case is precisely similar also with drones hatched from eggs laid by fertile workers. Mr. Vogel inserted in a hive of common bees, a drone-comb containing eggs laid by an Italian worker (which he had seen laying in a queenless stock), and removed the colony to an isolated locality. Italian drones were hatched, and two common queens, fecundated while these drones were flying, producing partly common and partly Italian workers. As there were then no other Italian drones in that neighborhood, those queens must have been fertilized by drones produced from the eggs of the fertile worker. That

this is possible, has been shown by the explicit and direct investigations of Prof. Von Siebold. During his sojourn at Seebach, he found in the sexual organs of such drones, the usual moving seminal filaments; and I made the same observation myself in several individuals sent to me for dissection, by Dr. Dönhoff.

2. *The queen bee is a female, and moreover the only perfect female in the colony.*

The evidence of the feminine nature of the queen bee can be much more easily furnished, than that of the masculinity of the drone. The *eggs* which, instead of seminal filaments, are found in the sexual organs of the queen, are well known to most apiarians; and the production of young from those eggs, preclude all possibility of mistake. Moreover, numbers of observant beekeepers have repeatedly seen queens lay eggs in worker and also in drone cells, from which eggs, workers and drones respectively in due time emerged. Hence, this point is placed beyond doubt or cavil, by the ascertained facts of the case.

Dissection, too, furnishes results entirely coincident with those supplied by observation. Beneath the dorsal integuments of the queen, and in the position occupied by the two testes in the drone, we find a pair of heart-shaped bodies, of considerable size, which occupy a large portion of the cavity of the abdomen, and are, like the testes, composed of a great number of minute tubes—from 160 to 180—bound together by enveloping air vessels (*fig.* 3, *a*). The bodies thus composed, are the *ovaries*. At the season of most abundant pasturage, each of the constituent ovarian tubes contains, in its lower part, one or more mature eggs, with perhaps a dozen more, in a less developed state, following them; so that we may safely estimate the entire number of eggs and egg-germs contained at one time, in the two ovaries, at not less than 4000. The case is different during the period of winter repose—when the number of egg-germs is reduced, according to my own observations, to one-half of that number, or perhaps less; and mature eggs are *then* rarely found.

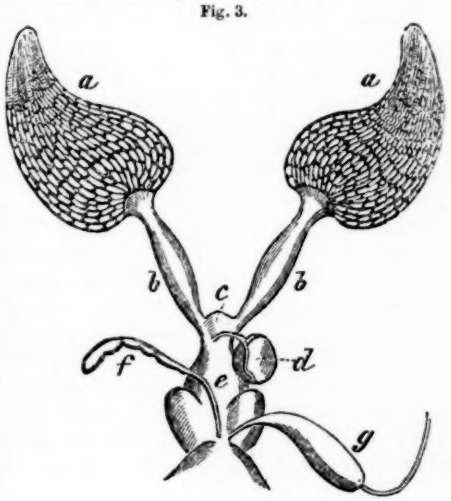
The incipient formation of these egg-germs occurs at a later stage in queens, than the development of the seminal filaments in drones. In royal pupæ nearly ready to emerge, such as I have frequently dissected, no egg-germs were present. In them, the contents of the ovarian tubes consisted of minute pellucid globules, precisely similar to the globules which precede the appearance of seminal filaments in the testes of the drones. The ovarian tubes in these immature queens were then also shorter and thinner than subsequently; and the development of the ovarian tubes was always correspondent to the egg-germs they contained.

The primary germs of the eggs invariably originate in the pointed upper ends of the tubes. There, a number of larger and more pellucid globules arise, which arrange themselves consecutively within the tube, each surrounded by a sort of halo, which is continually enlarging and becoming more opaque the further the globule descends in the tube. Out of this halo, the yolk is gradually educed, which, when it reaches the lower part of the tube, has also received a denser exterior envelope, the *chorion*, and therewith the formation of the egg terminates.

As soon as the egg-germs attain an appreciable size, they occasion a corresponding enlargement of that part of the ovarian tube in which they are situated. The globules also which happen to be placed between any two egg-germs, gradually increase in size, causing a similar enlargement of the ovarian tubes; so that these, in the case of fertile queens, finally somewhat resemble strings of minute irregular sized pearls. Still, we must not suppose that each enlargement of the tube is caused by an egg-germ or an egg—only each alternate one being thus produced.

b. As the masculinity of the drones is shown not solely by the contents of the germ-glands, but likewise by the structure of the ducts, so in like manner is the femininity of the queen manifested. The queen exhibits in these respects exactly the same relations which are seen in general in all female insects. These present a vagina near the termination of the excreting duct, and higher up within the dorsal covering, a small petiolated sac or spermatheca, designed to receive and retain the seminal matter derived from the male, and discharge it on the eggs successively passing its mouth in descending the oviduct.

Fig. 3.



In *fig.* 3, which represents the sexual organs of the queen bee, the vagina is designated by *e*, and the spermatheca by *d*. In *b b*, we have the bilateral oviducts, corresponding with the two seminal ducts of the drone; and in *c*, the short pear-shaped stem of the main duct—passages which, apart from other peculiarities, differ from the analogous parts of the male by their enlarged calibre, adapting them to the size and diameter of the egg.

The *vagina* (*e*), imperfectly recognized by earlier observers, is a large and capacious conical body, the posterior portion of which is developed into two ovoid lateral pouches, which I am inclined to think are designed to receive the already described horns (*fig.* 2, *k*), so prominent and conspicuous when the sexual apparatus of the drone is extruded and inverted. Still, I am not prepared to speak positively as to the relative purposes subserved by the several parts of the copulating organs, as I have hitherto not had an opportunity to dissect a queen retaining the disrupted penis.

The spermatheca (*fig.* 3, *d*), laterally connected with the neck of the vagina, is in the queen bee of unusual magnitude, so as to be readily seen even by the unaided eye. It is large enough to contain, according to my computation, probably twenty-five millions of seminal filaments.

Swammerdam, who notices and minutely describes this organ, regarded it as a gland secreting the glutinous matter which covers the eggs and attaches them to the bottom of the cell when laid; and he appears to have remained ignorant of its significance and importance. It was reserved for a French naturalist, M. Audouin, to discover its true character as a spermatheca, and thus furnish the clue for an intelligent explanation of the fact first observed by Janscha, that a single impregnation sufficed to render the queen bee fertile for life. This discovery has been fully confirmed by the investigations of later naturalists, and may easily be verified by means of the microscope, when a fecundated queen is dissected. In the virgin condition of the insect, the spermatheca contains a transparent liquid, in which no seminal filaments can be discovered.

The surface of the spermatheca is covered with a reticulated tissue of air vessels, giving it a considerable degree of elasticity and also preventing it from collapsing. But we find likewise within the coats of the spermatheca, a delicate muscular tissue, by the contraction of which, compression is effected and the contents forced out through the discharge pipe into the oviduct. The surface of this discharge pipe also shows a series of annular muscular fibres, particularly near its upper end, where they cause a decided enlargement of its diameter. Near the point of its connection with the spermatheca, two other glandular ducts, irregularly distributed over the surface of the latter, are inserted.

The vaginal orifice appears like a transverse incision across the apex of terminal wing of the abdomen, extending nearly to its anterior edge, and dividing it into two scoop-shaped parts, the interior surfaces of which, are a continuation of the external integument. As these parts are movable and turn on the anterior edge like a door on its hinges, it follows that the vaginal orifice may at times seem a narrow slit, and at others a widely gaping opening.

The *sting*, with its appendages, is situated above the vagina and between it and the excretory duct, and may be regarded as the terminal point of the abdomen, though it is not usually exposed to view, but remains retracted within its sheath. I do not propose to give a special description of this apparatus, merely remarking that such is found only in female insects; and its presence in the queen bee, may therefore be considered as an additional evidence of her femininity. It serves her, and other insects similarly provided, as a weapon of defence, being connected with a gland furnishing a highly acrid secretion, which is injected into the wound through a channel in the sting. In the queen, this gland is constituted of two long filaments, which extend in numerous convolutions between the vagina and the rectum, ultimately uniting and discharging their contents into a retort-like sac—the poison bag (*fig.* 3, *g*), the neck of which is furnished with several powerful muscles, and is inserted between the vagina and the sting-apparatus, or rather in the base of the latter. We find there also another hose-like appendage, first described by Von Siebold (*fig.* 3, *f*), which secretes an odorous unctuous fluid. Von Siebold was of opinion that this fluid is the glutinous matter which covers the eggs, and by which these are attached to the base of the cell. But as, according to my observations, the mature eggs are supplied with this glutinous matter while yet in the oviduct, this organ must have some other function. I incline to think that the oily secretion is designed to lubricate the sides of the barbed piercers, which rub longitudinally against each other when the sting is brought into action. I find some confirmation of this conjecture in the fact that when stung in the face, we always perceive a peculiar odor resembling that of this secretion; which warrants the inference that a more abundant effusion of it attends the act of stinging.

But it would seem also that the use of the sting is not restricted to purposes of attack or defence. It appears to serve the same purpose likewise in ovipositing. Undoubtedly, according to the observations of Dönhoff and Berlepsch, it is not then protruded; but we may, nevertheless, reasonably suppose that it exerts some influence on the placing of the egg, even though that be confined to giving it the proper direction as it glides along its curved and concave surface.

Some apiarians speak also of an *ovipositor;* but that which discharges the functions of an ovipositor in other female insects is, in the queen bee, developed as the sting-apparatus. She possesses no other ovipositor, and the sting-apparatus is scarcely entitled to be so designated. Others, again, have so named the conically protruded rectum, seen when the abdomen is forcibly compressed. This is obviously a *misnomer.*

b. That the queen is the *only* perfect female in the hive, is evident from the fact that after she is removed, there is *never* any egg laid from which a worker or a queen can be reared. Though, in a queenless colony, eggs be sooner or later laid by a fertile worker, these produce drones *only.* Hence, as the queen *alone* can procreate the three different kinds of bees—workers, queens and drones, it necessarily follows that she is the only perfect female in the colony.

c. In exceedingly rare instances, in spring, autumn and winter, two fertile queens are sometimes found in a hive. This happens when a superannuated queen is about to be discarded, yet chances to survive till her successor has been hatched and fecundated, while she continues to enjoy the attachment and fealty of some portion of her old adherents. It may also occur when, on uniting colonies in the fall, two queens are introduced, each of which is for a time protected by her own subjects. Once, indeed, the Baron of Berlepsch, as he informed me, found two highly fertile queens in one hive, in July; but the one had taken up her quarters on the brooding combs, and the other was ensconced in the honey chamber —though the workers made use of one common entrance. This case, however, is not particularly striking or important, because the original queen may have accidentally found her way into the honey chamber through a narrow passage, and was then unable to return; while the bees below, missing her and supposing her to be lost, proceeded to rear another. As the two never came in contact with each other, both were permitted to live.

3. *The workers are undeveloped females.*

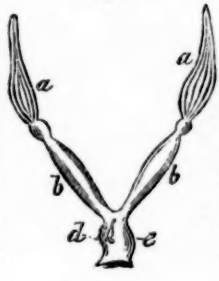
a. The femininity of the workers manifest from the structure of the sexual organs. No trace of a penis, such as we have seen is characteristic of the males, is to be found; but instead thereof, we have the transverse incision of the terminal abdominal ring, differing only in size from that of the vaginal orifice of the queen. In the cavity of the abdomen also, immediately adjacent to this transverse incision, we find the sting-apparatus situated just as in the queen; and this not in one or two individuals only, but in each and all, without exception. Workers destitute of sting—save from accident—have never yet been observed; and the sting alone is decisive as to their sex.

Yet it cannot be denied that the sting-apparatus of the workers differs, in many respects, from that of the queen. But these differences are still of a very subordinate character. They relate almost exclusively to size and form. The sting of the queen is curved downward, obviously, as was stated before, to give the extruded egg its proper direction; but in the workers, which employ it exclusively as a weapon, it is straight, and is thus, as well as from the number of barbs with which its piercers are furnished, better adapted to discharge its appropriate function.

The poison-bag and the lubricating gland, which, according to my examination of the workers, are situated in them just as in the queen, are however considerably smaller, and the glandular filament is single, in its entire length.

b. Though the workers, in the peculiar structure of the sexual organs, possess the most unmistakeable attributes of the female sex, they are, nevertheless, decidedly distinguished from the queen by being, at least for the most part, barren or sterile. But this circumstance is easily explained, when we examine the structure of the interior sexual organs. The proper anatomical preparation of these organs of the workers, is an exceedingly difficult task, and this led the elder naturalists, Swammerdam and Reaumur, to regard them as totally wanting. But since the results of the investigations made by Miss Jurine and Dr. Ratzeburg have become known, the erroneousness of those views has been acknowledged. We now know not only that such internal sexual organs exist, but also that, in their main typical features, they conform to the structure of those of the queen.

Fig. 4.



On a comparison of fig. 4 with fig. 3, which presents internal sexual organs of the queen, the resemblance will become sufficiently obvious. In *a* (*fig.* 4), we have the ovaries of the worker; in *b*, the two corresponding oviducts; in *c*, the vagina, with the stem of the main

oviduct; and in *d*, we even recognize the spermatheca, in its rudiments. But all these various organs are not only much smaller, but those parts precisely which are of most importance in the sexual functions of the queen, are here in the highest degree shrunken and stunted. The ovaries consist of only a few slender tubes, varying in number from two to twelve, and in their ordinary state contain no eggs or egg-germs. They are simply narrow canals, the contents of which, as in a queen before fecundation, consist of minute pale globules; and the cross section of the ovaries is scarcely larger than that of the bilateral oviducts. So likewise the vagina is only a small, though still comparatively capacious organ, lacking the lateral pouches, and scarcely distinguishable from the stem of the main oviduct situated immediately above. It is wholly impossible that the male genitals, if they could pass its external orifice, should find room in the vagina.

The spermatheca, too, is exceedingly minute, merely rudimental, and entirely incapable of receiving the spermatophore. Scarcely visible by the naked eye, it appears generally, according to my observations, as a mere analogue of the seminal duct. The sac itself is almost wholly obliterated, and the rudimentary remains of the glandular appendages are inserted in its slightly bulbous end, as they are in the queen, in the muscular bulb of the oviduct.

The difficulties above referred to as attending the anatomical preparation of these organs, do not result merely from the minuteness and delicate structure of the several parts, but from their connection with numerous air-vessels. In the pupa state, when these air-vessels have not yet attained their full development, and even in the earlier part of the subsequent period, the preparation is more easily accomplished; and the relative size of the parts seems then, too, to be considerably greater. I must doubt, however, whether, as I formerly supposed, a gradual shrinking takes place with advancing age. Certainly, after I had attained greater proficiency in preparing these organs, I seldom failed to detect them even in the oldest and most shrunken specimens.

Fig. 5.

c. In certain contingencies, some individuals among the workers acquire the capacity to lay eggs. Fig. 5 presents a view of the genitalia of such a bee. We readily perceive that a fertile worker differs from her sterile sister, merely in the more advanced development of the ovaries (*a a*). Yet the difference is not greater than that which is found between the ovaries of a recently hatched and a mature egg-laying queen. It results entirely from the development of egg-germs and eggs in the individual ovarian tubes—which proceeds precisely in the manner described in the case of the queen. The ovarian tubes then assume the appearance of a string of pearls, and become somewhat elongated—though never attaining the length of those of the queen. Nor are there ever, even under the most propitious auspices, half as many egg-germs found in an ovarian tube of a worker, as in one of those of a fecundated queen. Generally, the tubes are very irregularly and imperfectly furnished with eggs. Some individuals, indeed, are found in which only a few of the tubes exhibit such contents, and then only at isolated points—which sufficiently accounts for the fact that a fertile worker deposites her eggs in a much more irregular manner than a queen.

"INSTINCTIVE INTELLIGENCE."

This term has been employed by Coleridge ("Aids to Reflection," page 181,) to the nature of the Bee and other insects, in consequence of the *power* displayed by them "of adopting the proper means to proximate ends according to varying circumstances;" and his inference is drawn more especially from their devices employed in the construction of their dwellings. This definition of *intelligence* does not, however, appear to us sufficiently clear; unless Coleridge attributed that quality to the Hermit Crab and to numerous other creatures that have the power either to appropriate objects ready formed as dwellings, or to construct them from various materials, according to circumstances, but which rank very low in the animal scale.—Availing ourselves of the "aids to reflection" afforded by the latest and most eminent psychologists, we conclude that before such actions as those referred to by Coleridge, *apparently indicative* of intelligence, can be considered as truly so, it must be shown that the creatures are *conscious* that they are applying the proper means to the proximate ends. The line of demarcation is, however, exceedingly faint and difficult to distinguish; and Coleridge's reflections on the subject, beautiful though they be, are unfortunately not calculated to render it more easily definable.—SAMUELSON.

[For the Bee Journal.]

Kirby's Theory vs. Langstroth's.

The Rev. L. L. Langstroth, in his article in the Bee Journal, page 204, says, after a careful examination of my theory, he is unable to see any proof in support of it. I will endeavor to contrast his theory with mine, knowing that the theory which comes nearest to the law given by the Author of Nature to the honey bees, to govern them in their reproduction—which also controls them in all their varied instincts to preserve life, and causes them to lay up stores for themselves and man—the theory which comes nearest to the laws of nature, we must admit is nearest right. The Author of Nature has made but one general law for the reproduction of the animal and vegetable kingdom, which is that of male and female, in which the pollen or seed of each must be brought in contact with each other, in reproduction, and by that means alone. The Rev. L. L. Langstroth, in his work on the Honey Bee (which I consider one of the best works extant), gives his theory as follows:—The virgin queen, whilst a virgin, produces only drones. The queen is produced from the worker larvæ, and impregnated or made prolific by highly concentrated food secreted from honey, bee bread and water (*see page* 64). According to his theory, both the drone and the queen are produced contrary to the laws of nature. I intend to keep within that law, and to give it full force. My theory is that, to produce the three sexes, there must be three distinct infusions of the semen. First, to impregnate the ovary to produce the *drone;* second, the queen infuses the egg from her spermatheca to produce *workers;* third, the workers infuse the worker larvæ in the royal cells and the ovary of the young queen, *while yet in the cell*, with the semen of the drone. Her eggs, when she leaves the cell, will produce only drones, without further fertilization. In Huber's time, he believed the jelly so called, was of such fertilizing power as to cause the ovaries of the workers to become prolific. Dzierzon also believed that the fertile worker's eggs had in some way been impregnated, to cause them to produce drones only. As it is proved by Dr. Dönhoff, that it is the animal secretion found in the queen's cell that effects the physical change from a worker to a queen, I do not doubt that this goes far to substantiate my theory.

The reason why the queens mentioned by L. L. L. lay only drone eggs, or but few, is because the instincts of nature are not fully complied with, in not being fecundated by the drone, to enable her to lay eggs which will produce workers. This is a fact that the Rev. L. L. Langstroth very well knows, although he attempts to mystify it in his article against my theory. On the first publication in the Rural New Yorker of my theory, it was believed by many that it was impossible for the semen to retain its vitality in the combs, from the time the drones were destroyed until they made their appearance the following season. But now it is put to rest, if confidence can be placed in Mr. Hoffman's experiments, as given in the Bee Journal, page 213, showing that the spermatozoa, or the life part of the drone sperm, which is the same, after being a long time in water, or when taken from recently killed queens, or when moistened after having been a long time dry, would exhibit signs of life, confirming my theory. For, it is evident that it can be placed in the combs, and for a long time without destroying its vitality. The Author of Nature has evidently designed the tenacity of life of the semen of the drone after being given off, for the reproduction of a part of their race, it is well understood how the *worker* is produced. We must, therefore, look to the queen and drone to solve whatever of mystery still remains. I think the theory of the Rev. L. L. L. about the virgin queen's producing the drone, is in direct opposition to the law of God. When we see the reproduction of the queen and drone as the Author of Nature designed it, the mystery will be solved, and the Rev. L. L. Langstroth saved, in future, all trouble of *conscience* in giving a reason for the *number* of drones and the reproduction of artificial queens, in that he felt it his duty to caution his readers against infidelity, for his theory seeming not to be in accordance with the laws of God. See his third edition, pages 53 and 68.

Now, I will take up his theory of *Jelly*, or highly concentrated food, by which the worker-larva is impregnated, and the queen made prolific as far as *drones* are concerned. Would he not do well to caution his readers against infidelity on that point? I will take the analysis of the Jelly by Dr. Dönhoff, as given in the Bee Journal, see page 36, as proof of my position, that Jelly is "animal secretion," instead of vegetable (as declared by L. L. L. on the Honey Bee), and should be designated by some more appropriate name; since Jelly is never found in the stomach of the bee, showing that the Rev. L. L. L.'s theory, that *vegetable Jelly* changes the physiology from a worker-larva to that of a queen, rests wholly in his imagination and not in truth. L. L. L. says, "if Mr. Kirby says that *few* drones are used for this purpose, &c., he is entirely original in that expression." I have not believed or written anything that would give rise to such a conclusion,

but simply that nature had created drones for the propagation of their race. The article referred to, was condensed from minutes of mine relative to the genitalia of the drone and its probable uses; in which I expressed the opinion, that animal secretion or semen might be conveyed by the workers to the royal larvæ in two or three ways, of which I gave but one; it being placed there for the purpose of changing the physiology of the larvæ to that of a queen. Had the bees the power of speech, they would scoff at the idea of producing a queen by fecundating a worker-larvæ with a *vegetable compound*, or the virgin queens producing *males*, or the workers producing *artificial* queens. They would say that the Author of Nature had made provision for it in their seed.

Rev. L. L. L. dissents from my views of the theories of Dzierzon and Prof. Von Siebold, in reference to the productlon of drones without the male sperm, as "not giving the true history." With all due deference to these eminent observers, for their endeavors to give "a true history" of the honey bee, I would say that a fundamental truth not before discovered, would be no more valuable coming from them, than if made known by some humble though observing peasant. With nearly all egg-laying animals, their *eggs* are fecundated and not their *ovary*, at or about the time they break loose from their ovary. Consequently, the bee must be judged of by a different criterion; her *ovary*, not her *eggs* being fecundated; in which case, spermatic filaments would not be discoverable.

The Rev. L. L. L. has my sincere thanks for noting as correct, the statement made in my article respecting the copulation of the queen and drone bee; putting that subject at rest. As he admits that the workers fill their honey-bags with the juices of the "*smashed up drones*," I should like it better if he had used my language, "semen of the drone," than attempt to mystify it by using the term "smashed up drone" and "drone and worker-larvæ." I have no doubt, had Dr. Dönboff received the honey-bags for analyzation, he would say they contained *animal secretion*.

Mr. C. W. T. says, on page 186, he will mention one fact which will demolish effectually Mr. Kirby's theory in regard to rearing queens. I am happy to say, that that very fact which he has given, *confirms* my theory. Semen is retained in the combs from the time the drones are destroyed, at least until they appear the following season; and the bees are the same "disgusting little things" as I represented. Mr. L. P.'s communication, in the Bee Journal, page 205, which I read carefully, states that my theory is "the reverse of ten year's experience, and what hundreds of experiments show, &c. They must have been made before the Italian Bee was propagated in this country, or in Germany.

I should advise those who feel an interest in the propagation of the Italian Bee, to read the articles of the Rev. G. Kleine in the Bee Journal, commencing page 16, giving the opinions of eminent apiarians in Germany. Dzierzon could not account for the mystery of the different grades of hybrids. The Baron of Berlepsch states that "the brighter colored queens fecundated when common drones abound, sooner or later produce Italian workers only," and finally came to the conclusion that the *queen's daughters* were the best criterion of genuineness of the Italian Bee, as the *queens* exhibit far more of the hybrid phenomena, than the workers or drones. The Rev. L. L. L. mentions in the Bee Journal, page 166, the phenomena "that the larva which, if developed as a worker, would have been strongly colored, would, in its transformation into a queen, lose all its brilliant yellow," showing their natural proclivity to develop the black blood that they have received either in, or before their transformation. This is complained of by many, and of queens believed to be pure. And I hope to see investigation upon that point, determine whether animal secretion found in the royal cells, does not influence color and purity. This influence may appear slight at first, but sooner or later will develop itself. I believe the Italian Bee can be retained in its purity, with proper care, even in neighborhoods of common bees, if my theory should prove true, of which I have no doubt.

E. KIRBY.

Henrietta, N. Y., September, 1861

☞ That a few drones are occasionally, though rarely, retained over winter, in colonies which are in other respects in a perfectly normal condition, is undoubtedly true. This, however, is only an exception which proves the rule. Berlepsch says that, in three instances, he found some drones, at the close of winter, in colonies which contained only a small amount of worker eggs and larvæ and not yet any sealed brood; and infers that those drones must have have been retained from the previous summer. Had there been any brood nearly mature in capped cells, with some young workers already emerged, he would have suspected that the drones also had been recently produced from eggs laid at the approach of spring—though that would have been quite as singular and rare an occurrence, as the retention of a small number of drones during the winter, in a colony having a healthy fertile queen.

WAX AND HONEY.

The prevalent opinions respecting the origin and nature of wax and honey, as expressed in many treatises on bee culture, and as implied in the definition of the terms as given by the dictionaries, are essentially erroneous. The current impression, derived from these sources, is, that wax is contained in the honey or pollen, and is simply extracted by some process in the stomach of the bee; while honey is supposed to be *made* from the nectar of flowers. Precisely the converse of this is the fact.

1. Wax is a product elaborated by the bees. A simple experiment will suffice to demonstrate this conclusively. If bees be fed with a concentrated solution of loaf sugar and then confined in a box, we shall in the course of twenty-four hours, find between their abdominal rings thin scales or plates of wax, such as they use in building their combs. Now, probably no one will undertake to maintain that loaf sugar contains wax. It contains only the elementary ingredients of that substance, carbonic acid, hydrogen, and oxygen—which become separated in the body of the bee, and re-combined in different proportions and relations, thus resulting in the formation of wax.

2. It is otherwise in the case of honey. This is in no proper sense the product of the bees, but merely a substance collected by them from the boundless stores supplied by nature.

a. The matter collected by the bees undergoes no change before it is deposited in the cells. The nectar of flowers and freshly-gathered honey are, in all their constituents and properties, one and the same substance. Both have a sweet taste and an aromatic flavor. If we sip nectar from the calyx of the honeysuckle, we shall find that it has precisely the taste of freshly gathered honey. When I analysed the nectar of the wax plant (*Hoya thuya*), which exudes in large drops from the calyx of the flower, I found it was composed of sugar, gluten, and an aromatic substance—which are the constituents of common honey in its pure state.

I fed a colony with a solution of sugar colored with indigo, scented with lavender, and diluted with milk. When the bees had carried this into the cells of a new comb, no difference could be perceived between the contents of the cells and those of the feeding-box—they had the same color, the same taste, and the same smell.

b. If honey or the nectar of flowers remain in the cells, it will in process of time undergo a change. But this change is produced spontaneously, and not by the intervention of the bees, except merely so far as the internal heat of the hive may tend to accelerate it. It results, first, from the gradual evaporation of the aqueous particles contained in the nectar or fresh honey, till a certain degree of consistence is attained; secondly, from the still more gradual dissipation and loss of its agreeable aroma; and, thirdly, from the ultimate conversion of the more saccharine cane sugar, which constitutes an ingredient of the nectar of flowers, into the more insipid grape sugar—a change which all honey undergoes with the lapse of time.

ANALYSIS OF THE EXCRETA OF BEES.

Various opinions are held respecting the composition of the excrement of bees. While most persons regard the contents of the rectum as composed of the indigestible remains of pollen, Dr. Alefeld recently declared them to be uric acid. I have analyzed the excreta, and found the following ingredients:

1. *Remains of pollen.* I boiled the excrement in caustic potash lye slightly diluted. After filtering, I washed the residuum in hot dilute muriatic acid. What was left after again filtering, could from its insolubility, be only the remains of pollen. It appeared under the microscope like an indistinctly granular mass.

2. *Uric acid.* I immersed the excrement in concentrated sulphuric acid, in which uric acid remains undecomposed. After carefully decanting the liquid from the resulting carbonaceous mass, I added water; and then washed the precipitated matter in water. I now added one drop of *liquor ammoniaci* and one drop of muriatic acid. On heating, the mass assumed a purplish hue—the characteristic reaction of uric acid.

3. *Hippuric acid.* I boiled some excrement in caustic potash lye. After filtering, I added dilute muriatic acid, and obtained a precipitate which proved to be composed of uric and hippuric acid.

According to an approximative estimate, the excreta of bees consist of about one-third uric and hippuric acid, and the residue of indigestible portions of pollen. DÖNHOFF.

☞ Two moultings take place while the embryo bee is in its pupa state. The first occurs immediately after its first metamorphosis, or change from the larvæ condition, is completed; and the second when the pupa assumes a brownish hue. At this latter period the cuticle may easily be removed or stripped off, by means of a scalpel. That this cuticle is not an exuviæ or slough remaining from the larvæ state of the insect, is evident from the circumstance that it separates also from the antennæ, retaining the shape of those organs, which, as is well known, do not exist in the larvæ.—DÖNHOFF.

Bees, Wasps, and Humble Bees.

There is this remarkable natural difference between the instinctive habits of wasps and humble bees, and those of the honey bee, that, in the nests of the two former, egg-laying undeveloped females (fertile workers) regularly lay eggs while the queen is present and laying. Whereas, in colonies of the honey bee, none of the undeveloped females (fertile workers) begin to lay so long as a fertile queen is present in the hive. I have found it possible, however, to place the colony in such a condition that eggs will be laid simultaneously by the queen and the fertile workers.

I deprived three colonies of their queens, and afterwards removed also those reared by the bees. As soon as I found that eggs began to be laid by fertile workers, I returned to the several colonies their respective original queens, which were readily accepted—the bees having previously been fumigated and sprinkled with diluted honey. What followed? The queen commenced laying, and the fertile workers continued doing so likewise; for I found, as before, several eggs deposited in one cell, as well as eggs in pollen and royal cells, and there was a continual simultaneous production of drone brood and worker brood. Examining the colonies three weeks after the restoration of the queen, I found this irregularity still prevailing in each of them.

An excellent observer, Mr. Rothe, reports that in a similar experiment made by him, the fertile workers ceased to lay when the restored queen began to do so. The cause of this difference in the facts may perhaps be thus explained. In my colonies the fertile workers probably ceased to nurse the brood, and devoted themselves exclusively to the discharge of their newly assumed function, using the jelly prepared in their chyle stomachs for the production of eggs. Mr. Rothe's colony may have contained a large amount of unsealed brood, and the fertile workers resumed their duties as nurses, when the queen was restored. The jelly prepared in their stomachs was thus again diverted to a different use, and the development of eggs in their ovaries was forthwith discontinued. I am led to adopt this view, from having observed repeatedly that in small queenless colonies, the fertile workers always ceased to lay as soon as pasturage began to fail, and the eggs already laid were then promptly destroyed.—Dönhoff.

East Friesland, a province of Holland, containing 1200 square miles, maintains, on an average, 2000 colonies of bees per square mile.

Interesting Inquiries.

Let us direct your attention to a few of those features in the natural history of the honey bee, which, notwithstanding all that has been written on the subject, are still deserving of further investigation.

First, in regard to the bee's anatomy. Although it is conjectured that the compound eyes serve to convey to the brain images of *near*, and the simple ones, of *distant* objects, yet this is by no means certain; and any beekeeper contributing such data as would enable naturalists to decide the question, would render a great service to science, inasmuch as that which relates to the bee in this respect, refers also to the other insect races. The same remark applies also to the organs upon the antennæ and wings, as to whether they are organs of hearing or of smell. But this is a more difficult problem, and can be solved only by those who are thoroughly conversant with comparative anatomy as well as with the habits of the insect.

Again: with respect to the formation of the cells and the inquiry regarding their normal shape, there now exists an animated controversy, and all observers who have time and opportunity should direct their attention to this strange phase of insect architecture.

The most interesting subject for the consideration of naturalists and physiologists, however, is that of Parthenogenesis and the queen's power of fertilizing or leaving her eggs unfertilized, so as to produce either workers or drones. And when we reflect that it has but recently occupied the attention of Siebold in Germany, and Owen and others in England, and that the observations of any intelligent beekeeper may serve to throw additional light upon the subject, we hope this will be sufficient to enlist fresh volunteers in the service, who will aid to elucidate this wonderful phenomenon, which so strikingly illustrates the wisdom and resources of the Creator in directing the operations of animated nature.—Samuelson.

☞ Queens of second swarms appear to be less prolific than others during the first season, merely because their colonies are generally comparatively small. Introduce a liberal supply of brood in sealed cells, so that the population will speedily increase, and the queen will soon show that she has been incited to corresponding productiveness, and is fully qualified to assume and discharge the task which surrounding circumstances seem then to impose on her. Such a queen, so situated, being young and vigorous, will sometimes surpass an older one in fertility, even in her first summer.

[For the Bee Journal.]

Wintering Bees.

Mr. King, on page 203 of the Journal, says all his stocks suffered last winter from dysentery, but to a greater extent in the Langstroth hive; and he asks the reason why? He says, he had the honey board removed, but in case the tops were well made and painted, they would be so tight that vapor could not pass off from below. For wintering in a cellar or dark room, an inch auger hole on two sides of the top, covered with wire-gauze to guard against mice, will be found serviceable for ventilation. Mr. K.'s cellar may not be dry enough. My cellar answers tolerably well for vegetables, but is too damp for bees.

In my experience, dysentery has always affected my strongest colonies, and as I have always found their combs mouldy, I attributed it to dampness and restlessness, caused by over-population. My experience is very limited, having only lost three hives by it in fourteen years. It is said to oftener occur in painted hives, wintered either in the cellar or in the open air. When a painted hive becomes damp inside, the sun and air have but little effect in drying it. An unpainted hive will dry out much sooner, and vapor passes off through slight checks in the wood, which paint fills up. This does not apply to old hives, the sides thickly coated with bee-glue.

I, last year, at the suggestion of Mr. Cary, of Colerain, Mass., experimented with six Langstroth hives as follows:—I made boxes about six inches larger every way than the hives. The hives were on stands four inches high. I filled, between the sides and top of the hive and box, with dry leaves, leaving the entrance free for the bees to pass in and out. I gave the top of the box a strong inclination, to shed rain freely. I left the holes of the honey board open. One warm day in March, I removed the boxes from two hives, and examined the bees. I found them perfectly dry and in good condition. In replacing the honey board, I covered the holes to give increased warmth, to induce more rapid breeding. The following fortnight, the weather was very cold, accompanied by high winds. I then examined these two hives again, and found them in a deplorable state, suffering from condensed vapor, and breeding checked; while the hives still protected by the leaves were advancing rapidly in breeding, and were in a perfectly satisfactory condition. I ought to have left some of the holes in the honey board open, after removing the leaves.

Packing hives in boxes filled with leaves, will answer very well for those who have only a few hives; but it cannot, on account of expense, be recommended on a large scale. The French plan of putting the common box hive in a barrel filled with leaves or cut straw, the entrance being left open, is found to answer well; bees swarming earlier in hives thus cared for. This plan, too, would not answer on a large scale. It would require too large an outlay in barrels, and in summer they would be in the way, unless one had a large amount of spare room A few sheaves of straw, placed around a hive to protect it from strong winds, is of great service. Thatching is neater and better. Many bees are lost on windy days, in endeavoring to regain their hive, which, if in a sheltered situation, would be saved. An arbor vitæ hedge, or clumps of evergreens large enough to protect two or more hives from strong winds, and disposed with taste about the lawn, combine both the useful and ornamental. The arbor vitæ forms the closest hedge and gives the greatest protection in winter; but there are some hedge plants which yield a plentiful supply of bee food, that are on this account to be preferred. I must leave this subject to some one better acquainted with it, to enlighten the readers of the Journal.

Piercing winds, in winter and spring, injure bees more than intense cold, unaccompanied by wind.

E. P.

[For the "Bee Journal."]

As I have never seen any account of the distance that the queen will go to meet the drone, or the drone to meet the queen, I thought I would relate a circumstance that has happened in my apiary, this summer. I think it was some time the last of April or the first of May, I had a swarm that lost its queen. I found her dead at the mouth of the hive. I expected they would raise another queen and that she would be a drone-laying queen, as I had no drones nor did I expect any till very late, as my stocks were very light; and that she would be past the time of coupling with the drone, before I had any. As I said, I expected a drone-laying queen; but instead I have got an Italian raising queen. Of course she must have met the Italian drone somewhere, and there was none nearer than William W. Carey's; that is about three miles, till in June, when they were brought within about two miles of my apiary. Now whether the queen went that distance, or whether the drone came to see her, I leave for others to decide.

LEVI DAVENPORT.

Colerain, Sept. 7th, 1861.

☞ *Please send us the names of beekeepers.*

[For the Bee Journal.]

Bee Pasturage.

Those wishing to improve their bee pasturage are advised, on p. 211 of the Journal, to plant Maple, Locust, Chestnut and Linden trees, and to encourage others to do so. In setting out ornamental trees, it is surely worthy one's attention to have regard to their honey-producing power; and to select, with this end in view, those blooming at different times, rather than all of one kind, or those blooming at the same time. I should like to know the comparative value of these trees for producing honey, and also which varieties of those mentioned are the best.

For timber, the yellow locust is the most valuable. It is extensively planted on the western prairies, where it grows very rapidly, and is chiefly used for railroad sleepers. In southern Ohio, bees, some years, gather a large portion of their surplus honey from the Locust. Their industry during the yield from the locust is surprising. Where the tree grows in great numbers, they almost abandon all other sources of supply.

Twenty years ago, an old farmer in New Jersey raised from the seed, about 20,000 yellow locust trees, which, when tall enough not to be injured by cattle, he set out on the roadside, along his fences, and also thinned out his woodland and planted a locust wherever there was a chance for one to thrive. The majority are now worth $1 each for posts.

Some years since, a farmer in the west set out a very extensive peach orchard for fire-wood—the tree being of rapid growth in rich soil. When they began to bear, he marked those that yielded good fruit, saved them and cut the others as needed. In this way, he originated some fine fruit. He remarked that his bees gathered a good deal from blemished fruit, of which there was a large quantity, as he only picked for the use of his family. The same has been noticed in abundant peach years elsewhere; but near a good market, the crop is too carefully gathered for bees to obtain much from this source. "The nauseous Ailanthus" blooms very late The white clover, in my vicinity, suffered from drought this year before the Ailanthus blossomed, and bees worked with unusual activity upon it. I observed this upon an avenue of trees over one mile in length. I have been informed that the timber is extensively used in China (where it attains a large size), in ship building, and the leaves of the young trees for feeding a worm which produces an inferior silk, worn there by the lower classes. The chief need, in closely cultivated districts, is something to fill the gap between white clover and buckwheat.

E. P.

Preparation of Mead.

The following is the process of making mead, practised in Poland and Russia:

Take 120 lbs. of soft water and 20 lbs. of clear strained honey. Mix them well in a kettle of suitable size, and boil down the mixture to 80 lbs. —skimming it carefully while boiling. Then, pour it into a wooden vessel and let it stand to cool. While yet lukewarm, put in a pint of good stock yeast, stir thoroughly, and pour the whole into an oaken barrel (an empty rum or wine cask is the most suitable), which should be sufficiently large to contain ten gallons.

The liquor remaining over, is to be put in bottles, and used to fill up the barrel or cask during fermentation. Now, put into a small linen bag ¼ oz. cinnamon, ¼ oz. grains of paradise, ¼ oz. pepper, ¼ oz. ginger, ¼ oz. cloves, coarsely pulverized, and a large handful of dried elder blossoms. Suspend the bag by a string in the liquor, through the bunghole, and place the barrel in a dry airy cellar. Let the fermentation proceed during six weeks, keeping the barrel constantly full, from the contents of the bottles. Then, after gently removing the bag, rack off the clear liquor into another cask and close the bunghole lightly. Fermentation will still proceed moderately for six or eight weeks, before the liquor becomes clear. It must then be carefully racked off into bottles, and well corked. The lees remaining in the cask may be used in the preparation of an additional supply.

Mead thus prepared will keep for years. It is of a clear amber tinge, and has a vinous taste.

(For the "Bee Journal.")

HIVING SWARMS.

I have found it very advantageous, when hiving natural swarms, to sprinkle the cluster well with sugar-water, four or five minutes before shaking it down. I invariably do this when the cluster is accessible, or can be reached by means of a ladder. I pour the sugar-water into a tin basin, and use a common wisp or hand-brush for a sprinkler. This unexpected shower of sweets is an acceptable treat to the bees, mollifying their temper, and rendering them exceedingly tractable during the subsequent operations. If sufficient time is allowed after the sprinkling, for them to gorge themselves, few will be disposed to fly or sting.

Sprinkling with sugar-water may also be resorted to when the swarm issues before the beekeeper has a hive in readines for it. This will keep the swarm from rising or decamping; and by repeating it at intervals, time may be gained to make the necessary arrangements for its accommodation.

Hopewell. JOHN MILES.

The Antennæ of the Bee.

The antennæ or feelers of the bee are thread-like or *filiform*, as they are scientifically denominated; and if you examine them with a lens, you will find that they are composed of thirteen* cylindrical joints of nearly equal diameter, the second from the head being, however, much longer than the rest, comprising above one-third of the whole organ. With the exception of this one, all the annulated segments of the antennæ are studded over with perforations similar to those upon the third joint of the housefly. These perforations will be more readily detected through the employment of a low magnifying power, or, still better, if one of the antennæ be bleached with chlorine, and a portion of it be then submitted to microscopic investigation. Then you will be able not only to distinguish the peculiar structure of the organs with which it is covered, and to perceive that they are closed sacculi (little sacs), but you may also trace the central nerve that runs along the whole length of the feeler, giving off innumerable branches, one of which communicates with each of the cavities on the surface. This connection of the vesicles or sacculi with the nervous system, in the manner just described, denotes clearly that they are organs of sense.

Thus much has been determined with tolerable certainty; but now comes the problem—what is the character of the sensory function performed by these antennæ. Is it that of hearing, smell, or touch?

That they are organs of touch is decided beyond a doubt; but whether there is combined with this sense, that of hearing or smell, or whether the vesicles are organs that convey external impressions to the nervous centres in a manner appreciable by us, is still an open question; for however carefully they have been examined and compared with the sensory organs in other races of animals, no physiologist has yet been able to pronounce definitely as to their true function.

The bees employ their antennæ for various purposes; amongst others, to ascertain the character and form of objects and substances; as a guide in the construction of their cells; and to communicate information to one another—the last named end being accomplished by crossing their feelers with those of their congeners.

Whilst its antennæ remain unimpaired, the instincts of the bee are wonderfully active and acute; but as soon as it is deprived of these mysterious organs, its whole nature seems to undergo a change, and its psychical or mental state may then be compared to that of an imbecile or insane person—to one, in fact, who has "lost his senses."

With the view of illustrating this observation, we shall repeat two anecdotes related by Huber, and transferred from the pages of Kirby and Spence: "You have seen that the organ of the language of the ants is their antennæ. Huber has proved satisfactorily that these parts have the same use with the bees. He wished to ascertain whether, when they had lost a queen (intelligence of which traverses the whole hive in about an hour), they discovered the sad event by their smell, their touch, or any unknown cause. He first divided a hive by a grate, which kept the two portions about three lines apart, so that they could not come at each other, though scent would pass. In that part in which there was no queen, the bees were soon in great agitation, and as they did not discover her where she was confined, in a short time they began to construct royal cells, which quieted them. He next separated them by a partition, through which they could pass their antennæ, but not their heads. In this case the bees all remained tranquil, neither intermitting the care of the brood, nor abandoning their other employments, nor did they begin any royal cell. The means they used to assure themselves that the queen was in their vicinity, and to communicate with her, was to pass their antennæ through the openings of the grate. An infinite number of these organs might be seen at once, as it were, inquiring in all directions; and the queen was observed answering these anxious inquiries of her subjects in the most marked manner, for she was always fastened by her feet to the grate, crossing her antennæ with those of the inquirers. Various other experiments, which are too long to relate, prove the importance of these organs as instruments of communicating with each other, as well as to direct the bee in all its proceedings."

But the second anecdote will exhibit to us the disastrous effect produced by the loss of these organs.

"The amputation of *one* of the antennæ of a queen bee appears not to affect her perceptibly, but cutting off both these organs produces a very striking derangement of her proceedings. She seems in a species of delirium, and deprived of all her instincts; everything is done at random; yet the respect and homage of the workers towards her, though they are received by her with indifference, continue undiminished. If another in the same condition, be put in the hive, the bees do not appear to discover the difference, and treat them

* According to our enumeration, the antennæ of the drone have each ten of these articulations or cylindrical joints; those of the worker, eleven, and those of the queen, twelve.

both alike; but if a perfect one be introduced, even though fertile, they seize her, keep her in confinement, and treat her very unhandsomely. One may conjecture, from this circumstance, that is by those wonderful organs, the antennæ, that the bees know their own queen."

Although we are not in a position to state decidedly what is the precise function of the antennæ, we may mention that the opinion, derived chiefly from their anatomical structure, is gaining ground, that they are organs of hearing as well as of touch; and their mode of application leads to the same belief. The question is, however, as before stated, still undecided; and it presents a most interesting field of research, not only to those who employ the microscope in the investigation of the anatomy of insects, but also to naturalists who observe their habits; and in either case, the careful student can hardly fail to throw additional light on the inquiry.

There is no doubt whatever that the bee possesses the senses of touch, hearing, and smell, or functions corresponding therewith. The difficulty is to assign them a locality.—SAMUELSON.

☞ In reply to the doctrine still advocated by some that the queen habitually leaves her hive, at intervals and on various occasions, after fecundadation, which was based on the fact that fertile queens were sometimes found outside, Dzierzon relates the following occurrence:—"On a fine afternoon in September, I noticed that the bees of one of my colonies were flying very actively, and observed also that instead of centering chiefly around the entrance of the hive, their attention seemed mainly directed to a spot on the ground immediately below. I instantly surmised that their queen was there, and soon found her surrounded by a small cluster of workers—the entire population meanwhile exhibiting the wildest confusion. It was a beautiful Italian queen which I had frequently seen before, and I at once recognized her as the one belonging to the colony. Now, does this occurrence prove that the doctrine for which I contend, is erroneous? We shall ascertain this from the sequel. The queen was apparently uninjured in her wings, but was entirely unable to fly. Though she had for sometime ceased to lay, her abdomen was greatly enlarged, as though she were suffering from a species of dropsy. I nevertheless returned her to her hive, in which quiet and order were instantly restored. Next day, at about the same hour, this colony again exhibited similar disquiet and confusion. As the queen could not now be found outside, I opened the hive, and discovered her in one of the empty surplus honey-boxes, accompanied by a few bees, and wandering about in an aimless manner. I now examined her more closely, and saw that her antennæ were hanging motionless and that she obviously could no longer use them, they having probably been accidently injured and disabled. The mystery was now explained. The queen deprived of the use of these most important organs, crawled about in the hive without any conscious purpose; and, in short, behaved exactly like those which Huber had intentionally deprived of their antennæ—for those also wandered about confusedly, retired generally to some unoccupied part of the hive, which they endeavored to leave and did desert, so soon as they happened to find the entrance. Now what does the departure of the queen, in the case I have stated, prove? Nothing whatever, so far as regards a healthy and uninjured queen. If a deranged person recklessly rush through fire and flood, we do not thence infer that a sane man would engage in such amusements. Just as little can we deduce any valid conclusions as to the natural habits and instincts of the queen, from the actions of one which has been injured or mutilated, and assume that such an one occasionally or regularly leaves her hive for recreation. What the case does prove, is briefly, that Huber's observations and statements are correct, though many have regarded them as fanciful conceits. It is only when he hazards conjectures and surmises, that we find him partially in error. Nearly all his mistakes of this kind, have however been pointed out and corrected in the notes appended to Kleine's recent translation of "*New Observations*," rendering that work indeed, for all purposes of science, greatly superior to the original French publication."

☞ No second swarm issues from a colony unless *teeting* or *teeting* and *quahking* are previously heard. *Teeting* alone is heard when a queen has emerged from her cell, while the other royal embryos are not yet mature; whereas both *teeting* and *quahking* will be heard when one queen has emerged, while the others, though fully fledged, remain in their cells in apprehension of impending danger.

Prof. LEUCKART reports in the German *General Journal of Natural History, vol.* 3, that M. Asmusz, of Moscow, has discovered in his apiary the existence of an epidemic caused by a species of tapeworm (*Mermis albicans*), which is usually found only in the larvæ of some kinds of butterflies. Singularly enough, this disease is confined exclusively to the drones.

Bee Culture in Common Hives.

No. V.

BY F. W. GUNDELACH.

In June and July, when pasturage is good and the bees can gather honey plentifully, care must be taken to enable them to avail themselves freely of the abundance which nature supplies. They should not be permitted to waste the precious time, by clustering idly on the outside of the hive, because there is no longer room inside for them and the stores they could collect, or because excessive heat may prevent them from laboring within. In the latter case, we should give them requisite ventilation, and supply them with shade, if the hives are unfortunately so placed as to be exposed to the rays of the sun. In the former, they may be relieved by raising the hive and placing an cke under it, or by giving them access to a surplus honey box set on the top. Hives which have so greatly increased in weight, that there is reason to suppose that few of the combs remain empty, should be thus aided, even before the bees begin to cluster on the outside; for some colonies, in their eagerness to store up honey, will at times sacrifice both eggs and brood, casting them out of the cells, in order to make room for it. It may hence happen that such a colony has a superabundance of stores in the fall, with a disproportionably weak population; and is only the more exposed to the danger of perishing in the ensuing winter. On the contrary, a hive which has a strong population, and is nevertheless light, should not be enlarged by additions, either above or below; because the bees would most probably use for comb building the honey they gather, and fail to lay up a sufficient supply for the winter. A colony in this condition, needs only shade and ventilation.

All my hives, whether of straw or wood, have a hole two inches in diameter in the top, which is ordinarily closed with a wooden stopper. As soon as, from its increased weight, I judge that any of these is sufficiently filled, I remove the stopper, and invert over the hole an earthen pot, to the bottom of which, inside, a piece of empty comb has previously been attached. The bees soon take possession, and fill it with combs and honey, which, being generally unmixed with pollen, is of superior quality for table use. I have often removed pots containing from eight to ten pounds, secured by this simple and convenient process. I generally defer removing these pots till the fall, when the weather becomes cool, for then bees are rarely found remaining in them. It is true, I then occasionally find only empty combs in some of these pots, the bees having carried the honey down into the hive. But I reconcile myself to the disappointment, by supposing that, as there was room for it below, it has only been placed where it can be conveniently resorted to when needed; and that the bees have, by prudent anticipation, saved me the trouble of feeding them in the following winter or spring. If they should not need it, they will not waste it.

When the population of any of my old stocks has been so reduced, by frequent or late swarming, that it cannot properly avail itself of the existing abundance of pasturage, I adopt measures to strengthen it immediately. If left to recruit from its own brood, the season will generally have passed before it has become strong enough to labor with energy and effect, and fall flowers are usually a precarious resource. My observations have not favorably impressed me with the plan of transposing such a weakened colony with a populous one; and I have accordingly refrained from resorting to it. The weak colony will indeed readily accept the returning bees of the removed strong one; but the latter at once manifests an inordinately diminished activity, and, moreover, kills most of the bees of the weaker stock, which repair to it wholly unconscious of danger. If, however, I chance to have standing next to the weak stock which I desire to strengthen, a very populous one containing also much brood, I remove the latter while the bees are flying briskly, transferring it to some distant location in my apiary. I then shove the weak stock somewhat nearer to the place where the populous one stood. The returning bees will hover around for some time, looking for their old home, but finally enter the hive of the weak stock, and labor with their wonted industry. The bees of the removed colony will seem inactive for a few days, but being speedily strengthened by the emerging brood, will thenceforward work with redoubled energy. I am always careful to inject a tablespoonful of water into such removed hive, daily, during the first week, that there may constantly be a supply on hand for the benefit of the larvæ.

In districts where buckwheat is not cultivated and wild flowers are not abundant, pasturage usually begins to fail in August, and the drones are then expelled or killed. A colony which, under such circumstances, continues to retain its drones, may be regarded as queenless; and the beekeeper should, therefore, carefully note whether any or how many of his stocks fail to expel them. These should be examined, and, if found to contain no worker but only drone brood, each should be forthwith united with its nearest

droneless neighbor; though, if any be still populous and well furnished with stores, and we have a fertile reserve queen at command, its wants may be thereby advantageously supplied, if proper precaution be used when introducing the queen.

But I usually ascertain the condition of my stocks at a much earlier period, for I invariably examine all those in which young queens have been reared, shortly after the time has elapsed when these should have become fertile, and then apply the proper remedy if such be needed. For this reason, too, I am never much annoyed by robbing bees, for these find none but strong and healthy stocks in my apiary, able to defend themselves, and prompt to resist any attack which may be made.

The drones are sometimes expelled by the bees as early as the beginning of June, when the season happens to be peculiarly unfavorable; and at such time, also, the queen lays eggs very sparingly. Before undertaking in earnest to expel their drones, the bees drive them down from the combs, compelling them to take refuge on the bottom board. If, on lifting a hive, we find the drones thus crowded *en masse* on the bottom board, it is an infallible evidence that the colony has a fertile queen; though it is no proof that the colony is queenless, when they are not found crowded together there.

There is no more certain and expeditious mode of building up an apiary, where common hives only are used, than by preserving, for future occasions, hives filled with comb, and drumming out the first swarms. Even when unpropitious seasons occur, the expelled swarm, if placed in furnished hives, will rarely fail to secure sufficient supplies for the winter; while, if the summer prove ordinarily favorable, it will not only yield a surplus, but not unfrequently send forth a swarm in addition. Last year, my bees began to carry in pollen on the 26th of February, but during the months of March and April, and two-thirds of the month of May, the weather was so adverse, that one of my colonies which I weighed from curiosity, lost five pounds between the 15th of April and the 20th of May. Then a change occurred, and on the 22d of May, it had gained two pounds and a half, and thenceforward the improvement was rapid and gratifying. Still, though I could usually drum out my first swarms in the first week in May, I could not begin to do it that year before the end of the month. On the 26th, I drove out a swarm which I placed in a furnished hive, and observed then that the parent hive contained several sealed royal cells. On the 10th and 12th of June, two afterswarms issued from it, which I placed in empty hives. The driven swarm yielded a first swarm on the 26th of June, twenty-eight days after it was drummed out, and a second swarm on the 6th of July. Thus the parent stock increased to six, all of which gathered sufficient supplies for the winter.

Perils of Fumigation.

When communicating Mr. Hübler's process for introducing queens in a colony (BEE JOURNAL, *page* 111), we informed our readers that "great caution is required in the fumigation of bees with puck-ball fungus." Though we had never used it, we knew from the testimony of numerous concurring accounts, that bees gorged with honey were liable to be killed by its fumes; and that, moreover, if the small kind of puck-ball is used, bees in almost any condition were sure to be destroyed. But some recent experiments made by Mr. Huber, a very intelligent apiarian and old correspondent of the "Bienenzeitung," residing at Niederschopfheim, in the Grand Duchy of Baden, show that this is not the only danger attending the use of the article, nor the greatest evil which may result therefrom—besides failing to secure the safety of the introduced queen, if Mr. Hübler's instructions (not expressed, in all respects, with as much clearness as is desirable,) be not strictly followed. Thus—to begin with the latter point—Mr. Hübler says: "The operation should be undertaken only in the evening, shortly before dusk, and the entire mass of the bees be exposed to the fumes of the fungus." The special reason for operating only at the time mentioned is not assigned, though what is said was doubtless intended to intimate that the operator should seize the moment when *all* the bees have returned to the hive, so that "the entire mass" might be fumigated—leaving no individuals uninfluenced by the effects of the fumes, and disposed to attack the stranger queen when introduced. The operation may hence be performed, with equal safety, at any hour on a dull, cloudy or cool day, when the bees do not leave their hive. But in the heat of summer, if a hive is crowded with bees, it would often be exceedingly difficult to confine the whole population in the dusk of evening, even if some of the bees did not remain out over night; and there would, consequently, always be some risk attending the introduction of a queen, by this process, at that season. Mr. Huber experienced this to his sorrow. He fumigated a colony according to Hübler's instructions, and introduced a fertile Italian queen. Reposing implicit confidence in the success of the operation, he deferred examining the hive till the third day after, when he felt anxious to know what progress the queen had made in supplying the cells with eggs. To his mortification, he found her on the bottom board enveloped by a small cluster of workers; and though he immediately liberated her, and sought to secure her safety by placing her in a cage, she had already been so much injured that

she died the following night. He entertained no doubt that the small enveloping cluster was composed of bees, which, though belonging to the colony, had escaped fumigation, and then regarded and treated the introduced queen as an intruder. They were few in number, yet quite enough to compass her destruction. Here, consequently, is an unanticipated source of danger; and one against which it is difficult, if not impossible, always to guard.

But this is not all. The fumigation destroys all the eggs and unsealed brood in the hive. Such, at least, seems to be the fair inference from all the observations which Mr. Huber made in his own apiary, and the information obtained by him during an excursion to inspect the colonies of other beekeepers who had employed fumigation. —Last June, he fumigated a colony which had brood in three of its combs. This was done expressly to ascertain how the brood would be affected thereby. Three days thereafter, he examined the combs, and found all the eggs collapsed and the larvæ much shrivelled. Two days later, the larvæ was still more shrivelled and had become mouldy. Two days later still, not a vestige of eggs or larvæ remained in the cells; all had been removed, and the three combs contained only brood already capped when the operation was performed.

On the 3d of July, he fumigated another colony of common bees known to be in good condition, removed the queen, and placed an Italian queen on the top of the stupefied mass. On examining the hive next morning, he found this queen also beset by ten or twelve hostile workers. He released her; but as she was immediately assailed again by them, he placed her in a cage for security. Three days after this he liberated her, and she was then received and kindly treated. The hostile workers were probably such as had not been thoroughly affected by the fumes of the fungus, for a dozen or more returned and strove to enter the hive during the operation. In about thirty minutes, he allowed them to enter, and they were probably either not stupefied or with only transient effect.—This occurrence, in connection with his previous experience, convinced him that a queen can be safely introduced by this process, only if it be employed at a season or an hour when we can be absolutely certain that none of the bees are absent.

In this instance, also, the eggs and unsealed brood were destroyed, and all were removed out of the cells before the fourth day following; but, as in the previous case, none of the sealed brood was removed. These results show clearly that a colony may be very seriously damaged, if fumigation be resorted to when the combs are well stocked with eggs and larvæ.

But this is not the chief evil. We hazard the risk of encountering a far greater peril. Mr. Huber believes that foulbrood will frequently result from the employment of the puck-ball fungus, at times when there is brood in the hive. He frequently noticed cases of this disease in colonies which had been thus fumigated for the introduction of Italian queens, though they had previously been healthy. He learned further, on inquiry, that foulbrood prevails extensively in those districts where the fumes of the fungus were customarily employed to facilitate the union of stocks. In one of his own hives, the disease was developed within a week after it had been fumigated. He immediately removed the Italian queen, to check the production of brood, and thus arrested the malady.

The foulbrood, he supposes, does not originate from the decomposition of the unsealed larvæ destroyed by the fumes, for these are promptly removed from the cells by the bees; but from sealed brood, some of which perishes from the same cause. A cursory observer would suppose that the capped brood remains unaffected by the fumes, because it seems to emerge subsequently in a healthy condition. As a general thing, this may be so; but Mr. Hübler conceives, nevertheless, that, occasionally at least, a fatal result is produced, here and there, in some of the cells—probably in those not yet perfectly closed at the time of the operation. As this is not discovered by the bees till mortification or putrefaction has taken place, they do not cleanse these cells seasonably, as they do those in which eggs or larvæ are thus destroyed. Hence, this devastating disease, in its worst form, may originate in such cells, and be rapidly diffused in the hive, when the eggs laid by the newly introduced queen are hatched.

The destruction of the eggs and larvæ in his hives, Mr. Huber remarks, could not have been caused by too free a use of the fungus, as he was particularly careful in that respect. Nor could it have been caused by the heat of the smoke, which was introduced through the stem of a pipe, and made to impinge first against an empty comb. He is convinced that it resulted solely from the inherently noxious nature of the fume, fatal to the tender brood, though the adult bees survive.

Dzierzon has always declared himself averse to the use of puck-ball in his operations among bees, though he has nowhere, that we remember, assigned a reason for declining to employ or recommend it.

[For the Bee Journal.]

Cause of the Mortality among Bees last Winter.

During the last six or seven months, there has been circulated through one Journal and another, many statements of the mortality among bees; not only in this country, but in Europe also. But after stating that such and such apiaries have been nearly depopulated, or that Mr. A, B and C, have lost all of their young swarms and many of their old stocks, we are left in the dark as to the probable cause of such a calamity. At least, such is the case as far as I have seen, with the exception of your remarks in the March number of the "Bee Journal," in answer to a correspondent, who makes inquiry as to the cause of the malady that swept away so many bees the last winter and spring.

That the want of "sufficient upward ventilation" may, in some cases, be the cause of dysentery in bees, I do not doubt; but in the greater number of cases that fell under my own observation, especially in my own apiary, I am positive the disease was attributable to some other cause, viz: the quality of the food upon which they fed. One fact that transpired among my own bees I will relate, which, though not proof positive, strongly leans towards the support of such theory, to say the least.

I attempted the wintering of seven colonies, three old stocks and four young swarms. They were all very nearly in the same condition, as regards ventilation, amount of honey stored, &c.; but one of the old stocks had honey in their hive that had remained sealed for three years; another was fed about 10 lbs. of West India honey in the fall; while the remaining one had barely sufficient stores to carry them through the winter of '59. Consequently, it was on about the same footing with the young swarms in the fall following, with this difference: it had, probably, stored some food in the spring before the new swarms had set up for themselves. Probably, neither colony had less than 30 lbs. of honey stored for winter use. The mode of wintering was the same as I have adopted for the last five winters, with perfect success. The boxes were all removed and the caps put on—leaving the passage ways open. The hives removed to an unfinished chamber in the dwelling house, keeping them removed from the light and the influence of the sun, as much as possible. Now for the result.

Of the seven colonies, only two survived the winter. Those two, being the old stocks that had food independent of the supply gathered during the summer of 1860. The other stock lingered until the middle of April—the swarms having died before the 10th of February. Now, it appears plain to me, in this case, that the quality of the food consumed, had some effect in saving those two colonies; from the fact, that the honey gathered years previous in one hive, and that fed to the other, was consumed to the exclusion of that gathered in the summer and fall of 1860.

And in the case of the other stock, why did they linger along some two months longer than the swarms, and then die? Was it not because they had laid up a short supply of honey in the spring and early summer, not sufficient to carry them entirely through the cold season? Hence, having to resort to their late gathered stores, which induced disease, the effect was fatal.

But the question will be asked, why did honey contain such peculiar properties last year, and not the year before, or any other year? The reason I assign is this: Last year, owing no doubt to a peculiar state of the atmosphere, it being an extremely dry and withal cold season, a variety of aphis or plant louse was very abundant upon the common swamp alder. From the exudations of these insects, the bees gathered large quantities of honey; some swarms storing nearly 40 lbs. in about three weeks, during the latter half of August and first of September. This honey was of rather poor quality, though better than that gathered from the various weeds at the same time of the season; but after remaining in the hives some months, it was rather thinnish, and in flavor perceptibly acid. This acidity caused a very laxative state of the intestines, similar to dysentery; and the bees, being prevented by the cold from leaving their hives to void their fœces many days in succession, were unable to withstand the demand of nature, and were thus necessitated to void their excrements within the hives. The stench arising from such a state, was that of putrefaction. The effect of breathing this fœtid atmosphere, proved fatal to the entire colony, in from six to thirty days.

The present season, but very few of the aphis are to be seen upon the alders. Perhaps the countless millions of another variety, upon the crops of wheat and oats, may account for their disappearance in that quarter.

To guard against a like calamity and insure the safe wintering of bees in all seasons, I propose to feed each colony, late in autumn, 10 or 12 lbs. W. I. honey, as the empty brood comb in the centre of the hive will usually hold that amount. The cost would be but trifling, especially if bought in an unclarified state.—I think it would not exceed 20 cents per gallon, of 12 to 15 lbs.

Andover, Maine. FRYE, JR.

THE BEE MOTH.

Mr. Kaden, of Mayence, placed a second swarm in a new and clean hive, which had just been made for the purpose of this experiment, and set it remote from every other hive on his premises. Daily, at dusk, as soon as the bees ceased to fly, he carried this hive into the dwelling house, and deposited it in a chamber where moths or millers could not have access to it. On the eighth day, he drummed out the bees, took out the combs (containing pollen and honey, but no eggs or brood), and placed them under a bell-glass, so adjusted that no insect could enter. In less than three weeks, the combs were perfectly alive with worms. As the bee moth does not fly during the day, and the hive was regularly removed every evening to prevent its entrance at night, and the combs were all newly built, whence did these worms originate?

☞Some persons object to "special operations" and "artificial processes" in bee culture, because they regard them as "unnatural" and as "interfering with the instincts of the bee." But is not hiving a natural swarm an "artificial process?" Yet no one except the timid, objects to engage in that "special operation," though it is obviously a most violent "interference" with the instincts of the bee! Bees are not kept for the purpose of indulging them in the enjoyment of the "largest liberty" or gratifying their own wildest whims. The object and intention is rather to render them and their labors subservient to man's wants and desires; and he who can most completely control them, within their own proper sphere, is likely to derive the most benefit from them.

Mr. KLEIN, now a successful and distinguished apiarian at Tambuchshof, in Thuringia, once trapped and killed more than five thousand drones from a single old stock, which had for years been managed on the magazine or *nadiring* system. This colony had never yielded him any surplus honey, but required feeding every fall. Since he has abandoned that system, and introduced movable comb hives, a thousand drones could seldom be found at one time in his apiaries, and he obtains ample yields of honey.

Prest. BUSCH says he once saw thousands of bees gathering honey from the heads of common red clover, recently mown and partially wilted. They tore open the calyx at its base, and thus obtained access to the nectar which they are unable to reach when the blossom is full blown and fresh.

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S. B. Parsons, Flushing, L. I.
E. Kirby, Henrietta, N. Y.
Jas. S. Partridge, Albion, N. Y.
M. M. Baldridge, Middleport, N. Y.
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Monthly Management.

NOVEMBER.

The days are now rapidly becoming shorter, and the weather colder. The bees are seldom seen flying, except about noon, when the sun chances to shine bright and warm, but remain quiet in their hives, congregated in dense crowds between the combs—generally perfectly motionless, and not giving audible signs of life. Still, occasionally, fine days occur, which enable them to fly briskly and discharge their fœces. The later in the month they have an opportunity to do this, the better, and the more likely are they to endure, without inconvenience, the close confinement which awaits them during the winter. Should the bees of any colony in an apiary neglect to avail themselves of such an occasion, while others are eagerly embracing it, they should be roused by gently tapping on their hive or breathing into its entrance, particularly if they have not flown for a considerable time. Bees which have, during the latter part of the season, increased their stores much by collecting honey-dew, or which were fed liberally with diluted honey, will be greatly relieved and benefitted by such late excursions.

If any stocks are insufficiently supplied with stores, it would be rather late now to offer them diluted honey; better give them honey in the comb, if to be had, and movable frames are used. In common hives, sticks of candy may be inserted between the combs; or, where it can be done through a hole in the top, a small coarse sac filled with a stiff paste, composed of a mixture of honey and sugar, may be placed in the combs, over the cluster—covering it properly to prevent the escape of heat. Supplies may thus be administered even in midwinter, if care is taken not to disturb and arouse the bees.

Those who are in the habit of wintering their stocks in dry cellars or vaults, should be in no haste to remove them thither, but afford the bees full opportunity to enjoy any fine weather which may occur late in the season. It will be early enough to transfer them to their destined quarters, at the close of this month or the beginning of the next; for winter rarely sets in fully, before that time. The entrances of hives so placed, should not be closed. There will be no occasion for this, if the depository be cool and can be kept dark. A few sprigs or nails driven in the bottom board before the entrance, half an inch apart, will exclude mice, and still admit a sufficiency of air. Traps, properly baited, should be used to catch any rats or mice which may prove troublesome in the winter. Cats, if admitted, would be apt to disturb the bees, by running or leaping on the hives.

Bees, not removed from their summer stands, will rarely need any extra protection during the winter, if their hives are made of ordinarily suitable material, and they have a full supply of honey. Still, if the hives have a southern exposure, they should be shielded from the rays of the sun by erecting a temporary screen before them. The bees will then pass the winter in more uniform repose, and consume less honey. But, on mild days, when the bees can fly, the screen should be removed, to give them an opportunity to issue and discharge their fœces.

STUPEFYING BEES.

For conveniently stupefying bees, Dr. Raven employs the simple gunpowder squib, made as boys make them for their rather dangerous sports. A squib 1½ inch high and 1 inch in diameter is sufficiently large to subdue an ordinary colony—taking care that it be neither so moist as to prevent it from burning, nor so dry as to explode. A slow match is used for firing the squib, over which a wire gauze protector is set, to prevent the dropping bees from being burnt. The fumes do not perfectly stupefy the insects, but render them entirely manageable; and the recovering bees will be peaceably received by any stock to which we may wish to unite them.

Berlepsch thinks that the low and continued hummming heard in some hives, in extreme cold weather, is not produced by the action of the bees' wings. He once cautiously opened a hive on such an occasion, when the thermometer in the open air was at 24° below zero. The bees were packed in dense masses between the combs. The humming was still heard, though there was no motion of wings perceptible among the bees on the exterior of the clusters; and it is hardly conceivable that those confined in the interior would have room to move theirs. He suspects that the sound is produced by means of their organs of respiration, or results from some action of the tracheal system.

Berlepsch says he never saw drones emerge from their cells *before* the 24th day after the eggs were laid, and always only a few *on* the 24th. On the 25th and 26th they came forth in multitudes. Drone brood seems to requine a higher temperature than worker brood; for in some combs which he transferred to the sides of the hive the former perished, whilst the latter emerged only a day or two later than usual.